PATENT ABSTRACTS OF JAPAN

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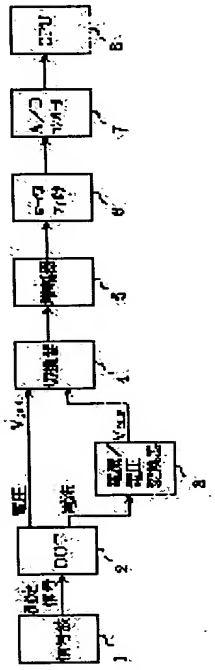
(72)Inventor : KOMATSU YASUAKI

(54) METHOD FOR MEASURING VECTOR VOLTAGE RATIO

(57)Abstract:
PURPOSE: To measure a vector voltage ratio at a high speed by using one A/D converter only.
CONSTITUTION: By supplying sine wave signals to arbitrary two terminals of a DUT 2, the voltage Vpot between the two terminals and converted voltage Vcur which is obtained by converting the current value flowing between the two terminals into a voltage value are outputted to an A/D converter 7 through a switch 4 which operates at the timing shorter than 1/4 of the period of the sine wave signals (shorter than 90° period when the period of the sine wave signals is 360°), for example, at the timing which is equal to 1/8 of the period of the sine wave signals. At the A/D converter 7, in addition, the voltages Vpot and Vcur are sampled at least once before the switch 4 makes switching operations and at a period which is equal to 1/4 of the measuring period. Then the vector voltages of the voltages Vpot and Vcur are found by performing digital signal processing on the sampling data about the voltage Vpot and Vcur by a well-known method.



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[Date of extinction of right]

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] Give a sinusoidal measurement signal to arbitration 2 terminal, and the voltage Vpot between these 2 terminals, and the conversion voltage Vcur which changed into the voltage value the value of the current which flows between these 2 terminals It outputs to an A/D converter through the change machine which operates so that it may choose any with both the voltage Vpot and Vcur they are. The aforementioned voltage Vpot and the aforementioned conversion voltage Vcur are sampled to predetermined timing by this A/D converter, respectively. In the vector voltage ratio measuring method which asks for a vector voltage ratio by carrying out digital signal processing of these sampling data, while operating the aforementioned change machine to timing shorter than one fourth of the periods of the aforementioned measurement-signal period By performing the sampling of both the aforementioned voltage Vpot and Vcur by the aforementioned A/D converter, respectively with one fourth of the periods of at least 1 time and the aforementioned measurement-signal period, before the aforementioned change machine carries out the next change operation The 0 times component and 90-degree component row of this voltage Vpot in the 1st system of coordinates based on the sampling phase of voltage Vpot are asked for the 0 times component and 90-degree component of this conversion voltage Vcur in the 2nd system of coordinates based on the sampling phase of the conversion voltage Vcur. Next, The vector voltage ratio measuring method characterized by asking for a vector voltage ratio with both the voltage Vpot and Vcur by performing amendment which changes the 0 times each component of both the voltage Vpot and Vcur and 90-degree component in both system of coordinates into each component in the same rotational coordinates.
[Claim 2] The vector voltage ratio measuring method according to claim 1 characterized by operating the aforementioned change machine with one eighth of the periods of the aforementioned measurement-signal period.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the above-mentioned method of measuring a vector voltage ratio at high speed using one A/D converter in the equipment which performs impedance measurements, such as LCR parts, concerning a vector voltage ratio measuring method.
[0002]
Background of the Invention] For example, usually, although it is necessary to measure the vector ratio of the voltage between terminals of this DUT, and the current which flows between these terminals in order to perform impedance measurement of the measuring objects-ed (henceforth DUT), such as LCR parts, after carrying out current / voltage conversion using the resistance for amperometries about current, it is asking for the vector ratio of voltage and current. By the way, the method of measuring the above-mentioned voltage Vpot between terminals and the conversion voltage (voltage which carried out the current / voltage conversion of the current) Vcur using one found the integral type A/D converter is learned conventionally. By this method, the proportionality error of an A/D converter can be offset by measuring both the aforementioned voltage Vpot and Vcur using one A/D converter. For this reason, by the above-mentioned method, it has the advantage which can measure a highly precise vector voltage ratio by easy circuitry and easy remedial operation.
[0003] By the way, in order to ask for the vector voltage of the conversion voltage Vcur of the current which flows to DUT twice in order to ask for a vector voltage ratio, and to usually ask for the vector voltage of the ends voltage Vpot of DUT, a total of 2 times and four measurement is required. Usually, when measuring the 0 times component of the sinusoidal signal of a certain frequency, or a 90-degree component by the found the integral type A/D converter, the reset time usually requires one or more periods. Therefore, from the conventional model, the time of four or more periods is needed for measurement at 1 time of a vector amplitude measurement, and there is a limitation in shortening the measuring time.
[0004] Moreover, a part of measurement signal is hit to the office dispatch number for a phase detection, and although the method of shortening the number of times of integration to 3 times also exists conventionally, in case an office dispatch number is generated from a measurement signal, by this method, there are problems -- it is easy to produce an error. Moreover, the method of ending measurement of vector voltage by one integration is also adopted using two or more found the integral type A/D converters. If this method is used, while high-speed measurement will be attained, circuitry becomes complicated and remedial operation becomes very complicated. Furthermore, when a found the integral type A/D converter is used, processing of offset voltage is needed, a detection phase is usually rotated 180 degrees, and since operation of finding the integral once again is needed, the measuring time serves as double precision of the above-mentioned measuring time. In addition, how to perform a phase-detection portion with software and enable high-speed measurement is also learned as used for a certain kind of network analyzer. By this method, although three A/D converters are used and measurement of three voltage can be ended in time of one period of an intermediate frequency, while part mark increase, there are problems, like the tracking error of the circuit to an A/D converter turns into an additional error.
[0005]
[Objects of the Invention] It aims at offering the vector voltage ratio measuring method which can end measurement in time of about one period of a measurement signal, without being proposed in order that this invention may solve the above troubles, and spoiling the simple nature of circuitry and remedial operation.
[0006]
[Summary of the Invention] In this invention, a sinusoidal signal is given to arbitration 2 terminal of DUT, and this voltage Vpot between 2 terminals and the conversion voltage Vcur which changed into the voltage value the value of the current which flows between these 2 terminals are outputted to an A/D converter through the change machine which operates to one eighth of timing, one fourth of the timing, for example, aforementioned sinusoidal period, shorter than period (it is period of 90 degrees when one period of a sine wave is made into 360 degrees) of the aforementioned sinusoidal And at the A/D converter, voltage Vpot and Vcur is sampled with one fourth of the periods of at least 1 time and the aforementioned measurement cycle, before the aforementioned change machine carries out the next change operation.
[0007] For example, an A/D converter may sample voltage Vpot and the conversion voltage Vcur by turns for every operation of a change machine, when voltage Vpot is inputted, after continuing the sampling of this Vpot, a multiple-times deed and a change machine operating and an input's switching to the conversion voltage Vcur, may continue and may perform the sampling of this Vcur the same number of times as the above. However, there is no change in the sampling data of the phase contrast of 90 degrees becoming a pair, and being obtained anyway.

TECHNICAL FIELD

[Industrial Application] this invention relates to the above-mentioned method of measuring a vector voltage ratio at high speed using one A/D converter in the equipment which performs impedance measurements, such as LCR parts, concerning a vector voltage ratio measuring method.

[0002]

Background of the Invention] For example, usually, although it is necessary to measure the vector ratio of the voltage between terminals of this DUT, and the current which flows between these terminals in order to perform impedance measurement of the measuring objects-ed (henceforth DUT), such as LCR parts, after carrying out current / voltage conversion using the resistance for amperometries about current, it is asking for the vector ratio of voltage and current. By the way, the method of measuring the above-mentioned voltage Vpot between terminals and the conversion voltage (voltage which carried out the current / voltage conversion of the current) Vcur using one found the integral type A/D converter is learned conventionally. By this method, the proportionality error of an A/D converter can be offset by measuring both the aforementioned voltage Vpot and Vcur using one A/D converter. For this reason, by the above-mentioned method, it has the advantage which can measure a highly precise vector voltage ratio by easy circuitry and easy remedial operation.

[0003] By the way, in order to ask for the vector voltage of the conversion voltage Vcur of the current which flows to DUT twice in order to ask for a vector voltage ratio, and to usually ask for the vector voltage of the ends voltage Vpot of DUT, a total of 2 times and four measurement is required. Usually, when measuring the 0 times component of the sinusoidal signal of a certain frequency, or a 90-degree component by the found the integral type A/D converter, the reset time usually requires one or more periods. Therefore, from the conventional model, the time of four or more periods is needed for measurement at 1 time of a vector amplitude measurement, and there is a limitation in shortening the measuring time.

[0004] Moreover, a part of measurement signal is hit to the office dispatch number for a phase detection, and although the method of shortening the number of times of integration to 3 times also exists conventionally, in case an office dispatch number is generated from a measurement signal, by this method, there are problems — it is easy to produce an error. Moreover, the method of ending measurement of vector voltage by one integration is also adopted using two or more found the integral type A/D converters. If this method is used, while high-speed measurement will be attained, circuitry becomes complicated and remedial operation becomes very complicated. Furthermore, when a found the integral type A/D converter is used, processing of offset voltage is needed, a detection phase is usually rotated 180 degrees, and since operation of finding the integral once again is needed, the measuring time serves as double precision of the above-mentioned measuring time. In addition, how to perform a phase-detection portion with software and enable high-speed measurement is also learned as used for a certain kind of network analyzer. By this method, although three A/D converters are used and measurement of three voltage can be ended in time of one period of an intermediate frequency, while part mark increase, there are problems, like the tracking error of the circuit to an A/D converter turns into an additional error.

[0005]

[Objects of the Invention] It aims at offering the vector voltage ratio measuring method which can end measurement in time of about one period of a measurement signal, without being proposed in order that this invention may solve the above troubles, and spoiling the simple nature of circuitry and remedial operation.

[0006]

[Summary of the Invention] They are one fourth of the periods (if one period of a sine wave is made into 360 degrees) of the aforementioned sinusoidal signal period about the conversion voltage Vcur which gave the sinusoidal signal to arbitration 2 terminal of DUT in this invention, and changed into the voltage value this voltage Vpot between 2 terminals, and the value of the current which flows between these 2 terminals. It outputs to an A/D converter through the change machine which operates to timing shorter than the period of 90 degrees, for example, one eighth of the timing of the aforementioned sinusoidal period. And at the A/D converter, voltage Vpot and Vcur is sampled with one fourth of the periods of at least 1 time and the aforementioned measurement cycle, before the aforementioned change machine carries out the next change operation.

[0007] For example, an A/D converter may sample voltage Vpot and the conversion voltage Vcur by turns for every operation of a change machine, when voltage Vpot is inputted, after continuing the sampling of this Vpot, a multiple-times deed and a change machine operating and an input's switching to the conversion voltage Vcur, may continue and may perform the sampling of this Vcur the same number of times as the above. However, there is no change in the sampling data of the phase contrast of 90 degrees becoming a pair, and being obtained anyway. That is, the sampling data of the voltage Vpot of a couple which has the phase contrast of 90 degrees mutually, and two or more sets of sampling data of the conversion voltage Vcur of a couple which similarly has the phase contrast of 90 degrees mutually will be obtained. In the former, when you perform a sampling with voltage Vpot or the conversion voltage Vcur with the phase contrast of 90 degrees, set in the period between the time when the 1st sampling (0 times) is performed, and the time when the 2nd sampling (90 degrees) is performed. Although ** and an A/D converter did not operate, since 0 times or 90 samplings of the conversion voltage Vcur are performed between zero sampling of for example, the voltage Vpot, and 90 samplings, one A/D converter can be used effectively by this invention. It can ask for the vector voltage of Vpot and Vcur by carrying out digital signal processing of the sampling data about the above-mentioned voltage Vpot and the conversion voltage Vcur by the well-known method.

[0008] By the way, the vector voltage of the voltage Vpot for which carried out in this way and it asked can be set to the system of coordinates (the 1st system of coordinates) based on the sampling phase of this Vpot, and can set the vector voltage of the conversion voltage Vcur to the system of coordinates (the 2nd system of coordinates) based on the sampling phase of Vcur. For

this reason, although the amendment which changes the 0 times component of the vector voltage in each system of coordinates and a 90-degree component into the 0 times component in the same system of coordinates and a 90-degree component is needed, an easy vector rotation operation or a complex operation can perform this amendment. Usually, amendment which doubles with the system of coordinates of another side the system of coordinates which are one side is performed.
[0009] In addition, when voltage Vpot is inputted, the sampling of this Vpot is continued. After a multiple-times deed and a change machine operate and an input switches to the conversion voltage Vcur, the sampling of this Vcur is continued, and when [when / as the above / same / carrying out a number-of-times line] (i.e., when performing the sampling by which plurality continued during the period when the change machine chose one side of voltage Vpot and the conversion voltage Vcur, and which is), a highly precise vector voltage ratio can be measured, shortening the measuring time sharply.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] Since it decided to perform 0 times or 90 samplings of the conversion voltage Vcur between zero sampling of voltage Vpot, and 90 samplings according to the measuring method of this invention as explained above, in spite of using one A/D converter, high-speed measurement of the time of about one period of a measurement signal is attained. this invention is applicable to measurement of the vector voltage ratio ranging from the again comparatively high cycle to low frequency.
[0024] Furthermore, when performing the sampling which plurality followed during the period when the change machine has chosen one side of voltage Vpot and the conversion voltage Vcur, highly precise vector voltage ratio measurement is attained, shortening the measuring time sharply. The impedance measurement of DUT in 100Hz and 120Hz can be finished by about 10 msecs, by this, since the part mark which can be inspected to around unit time in a production line can be increased, it can contribute to improvement in the speed of this line greatly, therefore the inspection fee per part can be reduced. Moreover, also in the research and development division, the measurement count around unit time can be increased and it also becomes possible to measure properties, such as time change of an impedance, more finely.

[Translation done.]

EXAMPLE

[Example] Drawing 1 is the block diagram showing the composition of the basic circuit for enforcing the vector voltage ratio measuring method of this invention. In this drawing, the measurement signal from the source 1 of a signal which outputs a sinusoidal voltage or a sinusoidal current is given to DUT (a coil, a capacitor, resistance, etc.)2, and the conversion voltage Vcur through the voltage Vpot between terminals of DUT, and the current / voltage converter 3 is inputted into the change machine 4. The change machine 4 is the timing mentioned later, switches by turns Vpot and Vcur which were inputted, and outputs them. Amplifier 5 is formed in the next step of the change machine 4, and the signal from the change machine 4 is outputted to a low pass filter 6 through amplifier 5. Especially the low pass filter 6 in this invention is formed for antialiasing, and in order to prevent the clinch produced when a sampling period is short, it becomes effective.
[0011] A/D converter 7 is formed in the latter part of this low pass filter 6, and this converter 7 is performing the sampling to the switch timing of the above-mentioned change machine 4, and the timing which has a fixed relation so that it may mention later. As A/D converter 7, what has a high-speed successive approximation type or a high-speed flash plate type etc. is usually used. And the sampling data from A/D converter 7 are temporarily stored in storage meanses, such as a register which is not illustrated, and a microprocessor (CPU) 8 processes calculation of the 0 times component later mentioned to these data, or a 90-degree component, amendment by the vector rotation operation, etc., and computes vector ratio voltage. Then, this vector ratio voltage is transformed into the voltage signal of an analog, and is sent to a proper output unit etc. In addition, in this example, since software realizes, a phase detection becomes unnecessary [a phase detector].
[0012] Hereafter, it explains using drawing 2 (A) - (C) focusing on the relation between switch timing with the change machine 4, and the timing of a sampling of A/D converter 7. Drawing 2 (A) is drawing showing both the waves of voltage Vpot and the conversion voltage Vcur. The period is the same although both have the arbitrary phase. Here, the change machine 4 of drawing 1 switches the output to Vcur or its reverse by turns from Vpot with one eighth of the periods (45-degree interval) of the above-mentioned measurement-signal period, and is outputting it to the next step. Drawing 2 (B) is the timing chart showing the situation of switching of the change machine 4, and the change state SW shows signs that Vpot is turned off and Vcur is [Vpot / ON and Vcur] turned on by OFF and the low, by the high level. In addition, the change is performed to timing unrelated to the phase of the above-mentioned measurement signal.
[0013] As shown in this drawing (C), A/D converter 7 is the same period as the period of the above-mentioned switching, and performs the sampling of Vpot or Vcur. However, when a sampling period is short, as for a sampling, it is desirable to carry out, after the output of the change machine 4 will be in a steady state. In this drawing (C), it is sampling near the pars intermedia of switching and switching. In addition, in this drawing (C), tX0, tX1, tX2, and ... have shown the sampling time of Vpot, and tY0, tY1, tY2, and ... have shown the sampling time of Vcur, respectively. Now, a sampling value [in / X0 X1, X2, ..., tY0, tY1 and tY2 of Vcur and ... / for the sampling value in tX0, tX1 and tX2 of Vpot, and ...] is made into Y0, Y1, Y2, and ... among these — for example, sampling numeric-value train XT=[X0 X1 X2 X3] T about Vpot — N1=[T] [1 0 -1 0] T and N2=[T] [0 -10 1] T If it takes advantaging, it can ask for two quadrature components (the 0 times component Vpot0 and 90-degree component Vpot90) of the vector voltage of Vpot. That is, the 0 times component Vpot0 of Vpot is [0014].
[Equation 1] The 90 0 times component component Vpot90 of Vpot0=XT-N1/2 =.(X0-X2)/2 and Vpot is [0015].
[Equation 2] It can ask by Vpot90=XT-N2/2= (-X1+X3) / 2. the same — carrying out — sampling numeric-value train XT=[Y0 Y1 Y2 Y3] T of Vcur — N1=[T] [1 0 -1 0] T and N2=[T] [0 -1 0 1] T If it takes advantaging, it can ask for two quadrature components Vcur0 of the vector voltage of Vcur, and the 90-degree component Vcur90. That is, the 0 times component Vcur0 of Vcur is [0016].
[Equation 3] Vcur0=YT-N1 / 2= (Y0-Y2) / 290-degree component Vcur90 is [0017].
[Equation 4] It can ask by Vcur90=YT-N2/2= (-Y1+Y3) / 2. By the way, by this invention method, the sampling of Vpot and Vcur is not performed by being in phase. That is, the system of coordinates based on the sampling phase of Vpot and the system of coordinates based on the sampling phase of Vcur are not the same. Therefore, although it is necessary to change the above Vpot0 and Vpot90, and Vcur0 and Vcur90 into the same system of coordinates, a vector rotation operation or a complex operation can amend this conversion easily so that it may state below. For example, it is [0018], when the value after Vcur0' and amendment of Vcur90 is set to 90 Vcur(s) for the value after amendment of Vcur, in order to double Vcur with the phase of Vpot.
[Equation 5]
It is set to Vcur0'=Vcur0, cos45 degree+Vcur90, and sin45 degree=(Vcur0+Vcur90)/21/2Vcur90'=-Vcur0, sin45 degree+Vcur90, and cos45 degree=(-Vcur0+Vcur90)/21/2. It can ask for a vector voltage ratio (a 0 times component is Vpot0/Vcur0', and a 90-degree component is Vpot90/Vcur90') easily from each above-mentioned formula.
[0019] In the above-mentioned example, although the change period of the change machine 4 was set as 45 degrees (1/8 of a measurement cycle), if it is an angle smaller than 90 degrees (1/4 of a measurement cycle), various kinds of periods, such as 60 degrees (1/6 of a measurement cycle) and 30 etc. degrees (1/12 of a measurement cycle), are employable. For example, as shown in drawing 3 (A), the change period of the change machine 4 is set as 60 degrees (1/6 of a measurement cycle). For example, the first sampling is performed from the change time tX0 about **Vpot at the time of 45-degree progress. ** Perform the sampling of the beginning about Vcur from the change time tY0 at the time of 45-degree progress, perform the 2nd sampling about **Vpot from the change time tX1 at the time of 15-degree progress, and perform the 2nd sampling about **Vcur from the change time tY1 at the time of 15-degree progress. If a sampling with Vpot and Vcur is performed one by one at time tX2, tY2, tX3, and tY3 like the following, Vpot0, Vpot90, Vcur0, and Vcur90 can be calculated like the above. And it can ask for a vector

(amendment which delays Vcur0 and Vcur90 60 degrees in this case is carried out) voltage ratio by giving amendment which doubles the phase of Vcur0 and Vcur90 with Vpot0 and Vpot90, for example. In addition, the measuring time in this case can be made into about 2/3 time compared with the former.

[0020] Moreover, in the above-mentioned example, although only one sampling was performed between a certain change time and next change time, multiple times can also be sampled in this period. For example, when it switches as shown in drawing 3 (B), and a period is set as 45 degrees like drawing 1 (B), two samplings (change time to 15 degrees and 30 degrees) are performed between the change time tXN and tYN about Vpot, XN0 and XN1 are calculated, similarly, two samplings are performed between the change time tYN and tXN+1 about Vcur, and YN0 and YN1 are calculated. However, N is 0, 1, 2, and ... here.

[0021] and -- X -- 00 -- X -- ten -- X -- 20 -- X -- 30 -- Y -- 00 -- Y -- ten -- Y -- 20 -- Y -- 30 -- from -- drawing 1 -- (-- A --) -- - -- (-- C --) -- setting -- having explained -- making -- the measurement result of the 1st vector voltage ratio -- obtaining -- from X01, X11 and X21, X31 and Y01, and Y11, Y21 and Y31 -- the same -- the measurement Highly precise measurement is attained by carrying out like this.

[0022] Moreover, as shown in drawing 3 (C), when change time is set as 60 degrees like drawing 3 (A), it sets. Perform two samplings (change time to 20 degrees, and 40 degrees) between a certain change time and next change time, and it is made to be the same as that of the above. Highly precise measurement is attained by obtaining the measurement result of the X01, X11 and X21, X31 and Y01, and Y11, Y21 and Y31 to 2nd vector voltage ratio in the measurement result of the X00, X10 and X20, X30 and Y00, and Y10, Y20 and Y30 to 1st vector voltage ratio. Although the above-mentioned example explained the case where it asked for the impedance of DUT, this invention is not limited to this, is used suitable for the equipment which requires measurement of a vector voltage ratio, for example, the measuring instrument which needs to ask for the vector ratio of a reference voltage and a test voltage like a network analyzer, and can enable high-speed measurement.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the example of basic circuitry to which the measuring method of this invention is applied.
[Drawing 2] It is drawing showing one example of the measuring method of this invention, and drawing in which (A) shows the wave of a measurement signal, drawing in which (B) shows the operating state of a change machine, and (C) are drawings showing the sampling timing of an A/D converter.
[Drawing 3] Drawing in which being drawing showing other examples of the measuring method of this invention, and showing the operating state of a change machine when (A) makes the change period of a change machine 60 degrees, and the sampling timing of an A/D converter, Drawing showing an example when a change machine period is 45 degrees, before this change machine carries out the next operation, in case (B) performs a sampling twice, and (C) are drawings showing the example in the case of performing a sampling twice, before this change machine carries out the next operation, when a change machine period is 60 degrees.

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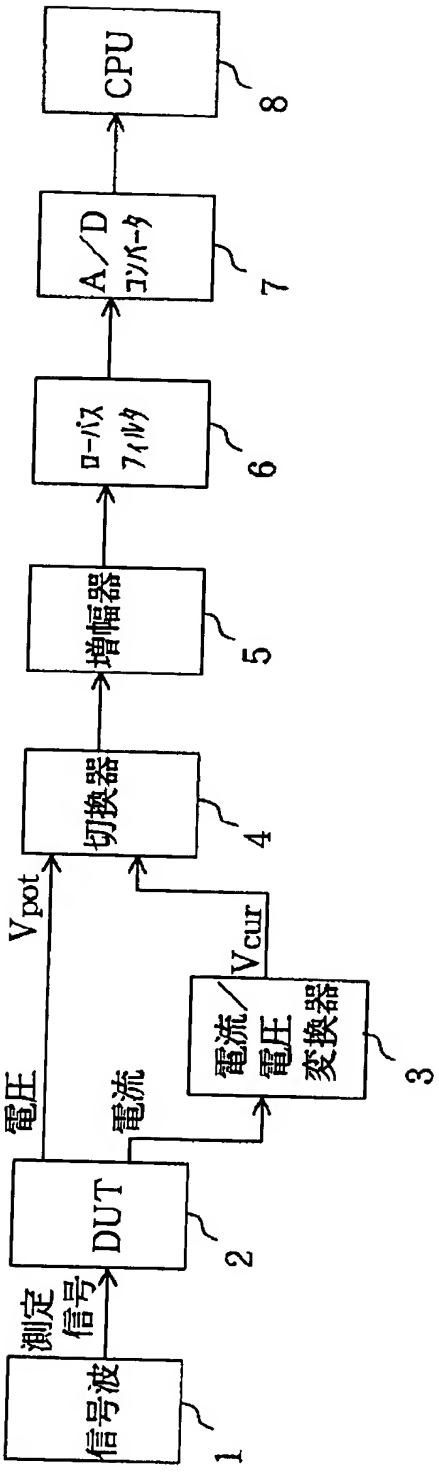
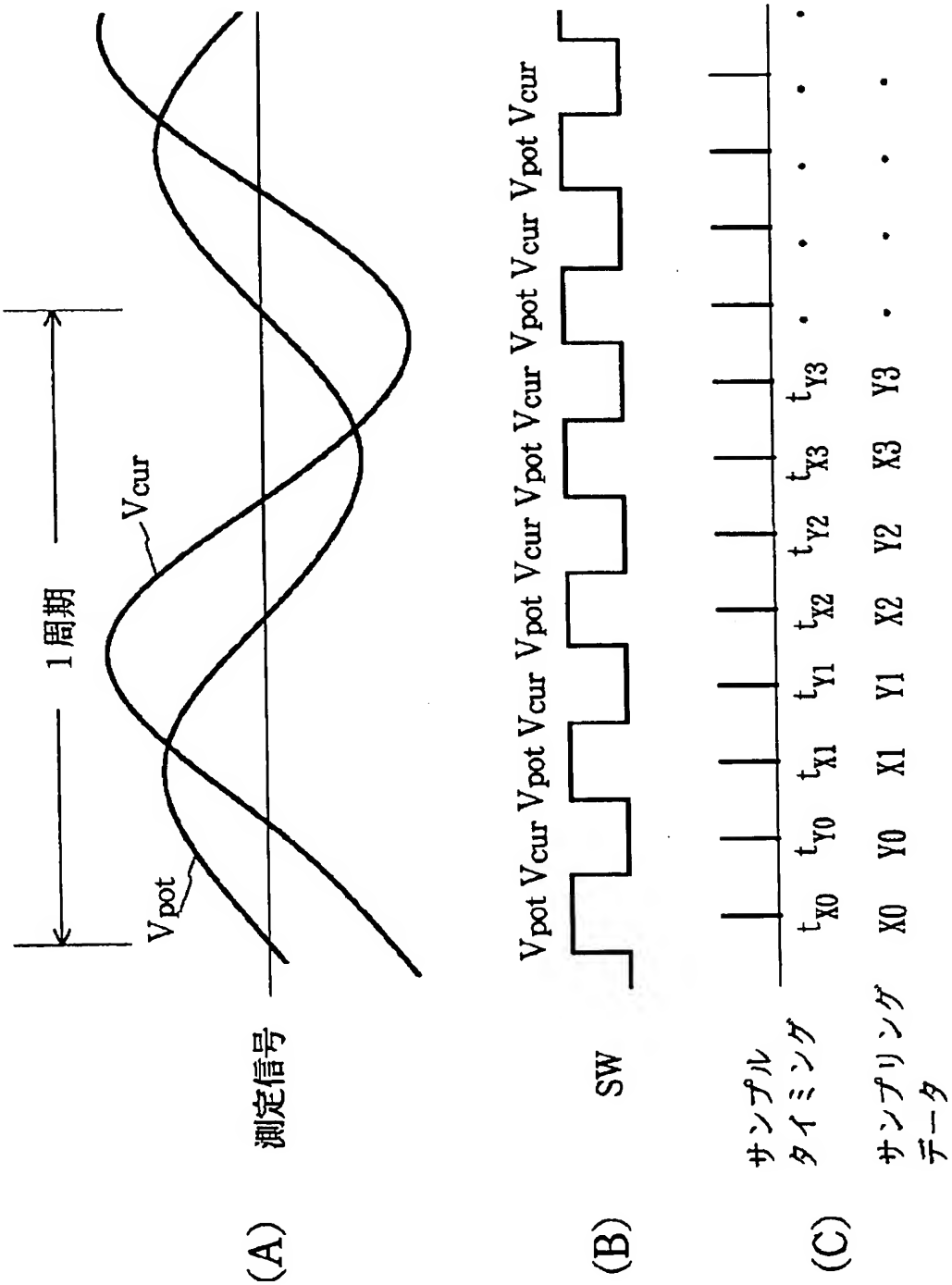
DRAWINGS

[Drawing 1]


信号波
1
測定信号
DUT
2
電圧
電流
電流/電圧変換器
3
Vpot
Vcur
切換器
4
増幅器
5
ローパスフィルタ
6
A/Dコンバータ
7
CPU
8

[Drawing 2]


(A)
測定信号
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Vcur
Vpot
(B)
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(C)
サンプル
タイミング
サンプリング
データ
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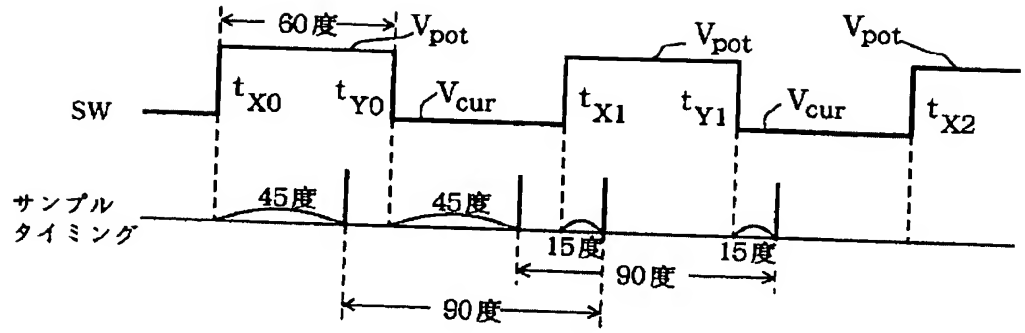
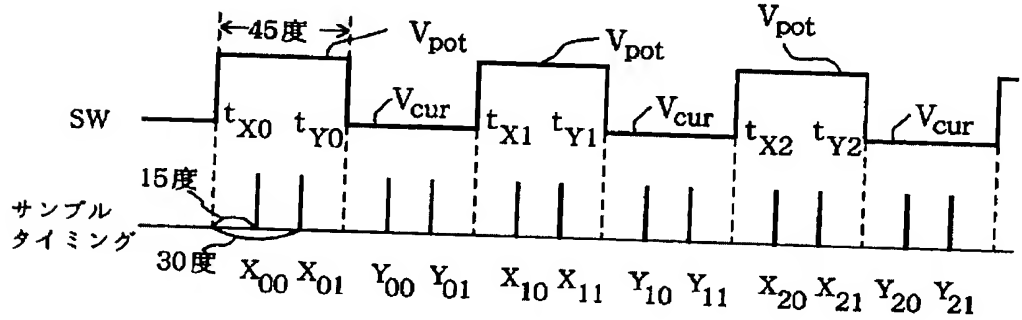
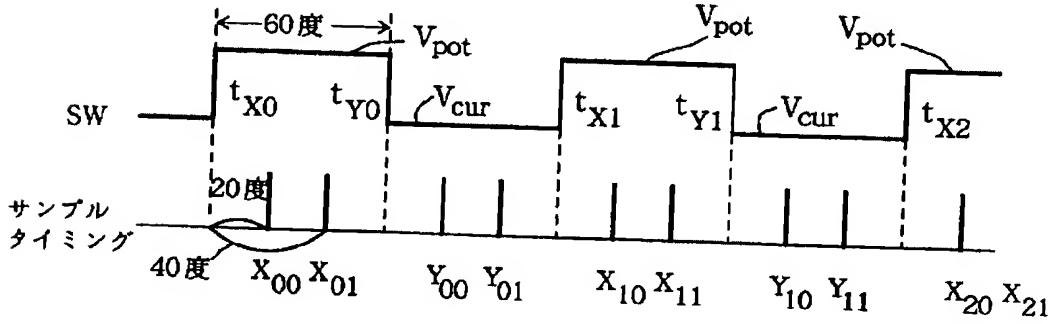
[Drawing 3]



(A)



(B)



(C)

[Translation done.]

CORRECTION or AMENDMENT

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G01R 19/10 .
27/02 .

[FI]

G01R 19/10 B .
27/02 A .

[Procedure revision]
[Filing Date] October 21, Heisei 10.
[Procedure amendment 1]
[Document to be Amended] Specification.
[Item(s) to be Amended] Whole sentence.
[Method of Amendment] Change.
[Proposed Amendment]
[Document Name] Specification.
[Title of the Invention] A vector voltage ratio measuring method and a vector voltage ratio measuring device.
[Claim(s)]
[Claim 1] Give a sinusoidal measurement signal to two terminals of the measuring object-ed, and the voltage Vpot between these 2 terminals, and the conversion voltage Vcur which changed into the voltage value the value of the current which flows between these 2 terminals It outputs to an A/D converter through the change machine which operates so that both the voltage Vpot and Vcur may be chosen. It is the vector voltage ratio measuring method which asks for a vector voltage ratio by sampling the aforementioned voltage Vpot and the aforementioned conversion voltage Vcur to predetermined timing by this A/D converter, respectively, and carrying out digital signal processing of these sampling data.
While operating the aforementioned change machine to timing shorter than one fourth of the periods of the aforementioned measurement-signal period
0-degree component and 90-degree component row of this voltage Vpot in the 1st system of coordinates based on the sampling phase of voltage Vpot are asked for 0-degree component and 90-degree component of this conversion voltage Vcur in the 2nd system of coordinates based on the sampling phase of the conversion voltage Vcur by performing the sampling of both the aforementioned voltage Vpot and Vcur by the aforementioned A/D converter once [at least], before the aforementioned change machine carries out the next change operation.
Then, the vector voltage ratio measuring method characterized by asking for a vector voltage ratio with both the voltage Vpot and Vcur by performing amendment which changes 0-degree each component and 90-degree component of both the voltage Vpot and Vcur in both system of coordinates into each component in the same rotational coordinates.
[Claim 2] The vector voltage ratio measuring method according to claim 1 characterized by sampling both the aforementioned voltage Vpot and Vcur by the aforementioned A/D converter with one fourth of the periods of the aforementioned measurement-signal period, respectively.
[Claim 3] The vector voltage ratio measuring method according to claim 1 or 2 characterized by operating the aforementioned change machine with one eighth of the periods of the aforementioned measurement-signal period.
[Claim 4] The source of a signal which gives a sinusoidal measurement signal to two terminals of the measuring object-ed,
The current / voltage converter which changes into a voltage value the value of the current which flows between these 2 terminals,
The change machine which inputs the voltage Vpot between these 2 terminals, and the conversion voltage Vcur from the aforementioned current / voltage converter, and chooses and outputs both the voltage Vpot and Vcur,
The A/D converter which inputs the voltage from the aforementioned change machine and samples the aforementioned voltage Vpot and the aforementioned conversion voltage Vcur to predetermined timing, respectively,
It is the vector voltage ratio measuring device which comes to have the signal-processing means which carries out digital signal processing of the data sampled by the aforementioned A/D converter.

The aforementioned change machine operates to timing shorter than one fourth of the periods of the aforementioned measurement-signal period.
The aforementioned A/D converter samples both the aforementioned voltage Vpot and Vcur once [at least], before the aforementioned change machine carries out the next change operation.
0-degree component and 90-degree component of this voltage Vpot in the 1st system of coordinates based on the sampling phase of the aforementioned voltage Vpot in the aforementioned signal-processing means, While asking a row for 0-degree component and 90-degree component of this conversion voltage Vcur in the 2nd system of coordinates based on the sampling phase of the conversion voltage Vcur The vector voltage ratio measuring device characterized by what is asked for a vector voltage ratio with both the voltage Vpot and Vcur by performing amendment which changes 0-degree each component and 90-degree component of both the voltage Vpot and Vcur in both system of coordinates into each component in the same rotational coordinates.
[Claim 5] The aforementioned change machine is a vector voltage ratio measuring device according to claim 4 characterized by sampling both the aforementioned voltage Vpot and Vcur with one fourth of the periods of the aforementioned measurement-signal period, respectively.
[Claim 6] The aforementioned change machine is a vector voltage ratio measuring device according to claim 4 or 5 characterized by operating with one eighth of the periods of the aforementioned measurement-signal period.
[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the above-mentioned method and the above-mentioned equipment which can measure a vector voltage ratio at high speed using one A/D converter in the equipment which performs impedance measurements, such as LCR parts, concerning a vector voltage ratio measuring method and a vector voltage ratio measuring device.
[0002]
Background of the Invention] For example, usually, although it is necessary to measure the vector ratio of the voltage between terminals of this DUT, and the current which flows between these terminals in order to perform impedance measurement of the measuring objects-ed (henceforth DUT), such as LCR parts, after carrying out current / voltage conversion using the resistance for amperometries about current, it is asking for the vector ratio of voltage and current. By the way, the method of measuring the above-mentioned voltage Vpot between terminals and the conversion voltage (voltage which carried out the current / voltage conversion of the current) Vcur using one found the integral type A/D converter is learned conventionally. By this method, the proportionality error of an A/D converter can be offset by measuring both the aforementioned voltage Vpot and Vcur using one A/D converter. For this reason, by the above-mentioned method, it has the advantage which can measure a highly precise vector voltage ratio by easy circuitry and easy remedial operation.
[0003] By the way, in order to ask for the vector voltage of the conversion voltage Vcur of the current which flows to DUT twice in order to ask for a vector voltage ratio, and to usually ask for the vector voltage of the ends voltage Vpot of DUT, a total of 2 times and four measurement is required. Usually, when measuring 0-degree component or 90-degree component of a sinusoidal signal of a certain frequency by the found the integral type A/D converter, the reset time requires one or more periods. Therefore, from the conventional model, the time of four or more periods is needed for 1 time of a vector amplitude measurement, and there is a limitation in shortening the measuring time.
[0004] Moreover, a part of measurement signal is hit to the office dispatch number for a phase detection, and although the method of shortening the number of times of integration to 3 times also exists conventionally, in case an office dispatch number is generated from a measurement signal, by this method, there are problems — it is easy to produce an error. Moreover, the method of ending measurement of vector voltage by one integration is also adopted using two or more found the integral type A/D converters. If this method is used, while high-speed measurement will be attained, circuitry becomes complicated and remedial operation becomes very complicated. Furthermore, when a found the integral type A/D converter is used, processing of offset voltage is needed, 180 degrees of detection phases are usually rotated, and since operation of finding the integral once again is needed, the measuring time serves as double precision of the above-mentioned measuring time. In addition, how to perform a phase-detection portion with software and enable high-speed measurement is also learned as used for a certain kind of network analyzer. By this method, although three A/D converters are used and measurement of three voltage can be ended in time of one period of an intermediate frequency, while part mark increase, there are problems, like the tracking error of the circuit to an A/D converter turns into an additional error.
[0005]
[Objects of the Invention] It aims at offering the vector voltage ratio measuring method and vector voltage ratio measuring device which can end measurement in time of about one period of a measurement signal, without being proposed in order that this invention may solve the above troubles, and spoiling the simple nature of circuitry and remedial operation.
[0006]
[Summary of the Invention] They are one fourth of the periods (if one period of a sine wave is made into 360 degrees) of the aforementioned sinusoidal signal period about the conversion voltage Vcur which gave the sinusoidal signal to arbitration 2 terminal of DUT in this invention, and changed into the voltage value this voltage Vpot between 2 terminals, and the value of the current which flows between these 2 terminals. It outputs to an A/D converter through the change machine which operates to timing shorter than the period of 90 degrees, for example, one eighth of the timing of the aforementioned sinusoidal period. And at the A/D converter, voltage Vpot and Vcur is preferably sampled with one fourth of the periods of the aforementioned measurement cycle once [at least], before the aforementioned change machine carries out the next change operation.
[0007] For example, an A/D converter may sample voltage Vpot and the conversion voltage Vcur by turns for every operation of a change machine, when voltage Vpot is inputted, after continuing the sampling of this Vpot, a multiple-times deed and a change machine operating and an input's switching to the conversion voltage Vcur, may continue and may perform the sampling of this Vcur the same number of times as the above. In this case, sampling data with a phase contrast of 90 degrees become a pair, and will be obtained, and the sampling data of the voltage Vpot of a couple which has the phase contrast of 90 degrees mutually, and two or more sets of sampling data of the conversion voltage Vcur of a couple which similarly has the phase contrast of 90 degrees mutually will be obtained. In the former, when you perform a sampling with voltage Vpot or the conversion voltage Vcur with the phase contrast of 90 degrees, set in the period between the time when the 1st sampling (0 degree) is performed, and the time when the 2nd sampling (90 degrees) is performed. Although ** and an A/D converter did not operate, since the sampling (0 degree or 90 degrees) of the conversion voltage Vcur is performed between the 0 degree sampling of for example, the voltage

Vpot, and a 90-degree sampling, one A/D converter can be used effectively by this invention. And it can ask for the vector voltage of Vpot and Vcur because a signal-processing means carries out digital signal processing of the sampling data about the above-mentioned voltage Vpot and the conversion voltage Vcur by the well-known method.
[0008] By the way, the vector voltage of the voltage Vpot for which carried out in this way and it asked can be set to the system of coordinates (the 1st system of coordinates) based on the sampling phase of this Vpot, and can set the vector voltage of the conversion voltage Vcur to the system of coordinates (the 2nd system of coordinates) based on the sampling phase of Vcur. For this reason, although the amendment which changes 0-degree component and 90-degree component of vector voltage in each system of coordinates into 0-degree component and 90-degree component in the same system of coordinates is needed, an easy vector rotation operation or a complex operation can perform this amendment. Usually, amendment which doubles with the system of coordinates of another side the system of coordinates which are one side is performed.
[0009] In addition, when voltage Vpot is inputted, the sampling of this Vpot is continued. After a multiple-times deed and a change machine operate and an input switches to the conversion voltage Vcur, the sampling of this Vcur is continued, and when [when / as the above / same / carrying out a number-of-times line] (i.e., when performing the sampling by which plurality continued during the period when the change machine has chosen one side of voltage Vpot and the conversion voltage Vcur), a highly precise vector voltage ratio can be measured, shortening the measuring time sharply.
[0010]
[Example] Drawing 1 is the block diagram showing the composition of the basic circuit for carrying out this invention. In this drawing, the measurement signal from the source 1 of a signal which outputs a sinusoidal voltage or a sinusoidal current is given to DUT (a coil, a capacitor, resistance, etc.)2, and the conversion voltage Vcur through the voltage Vpot between terminals of DUT2, and the current / voltage converter 3 is inputted into the change machine 4. The change machine 4 is the timing mentioned later, switches by turns Vpot and Vcur which were inputted, and outputs them. Amplifier 5 is formed in the next step of the change machine 4, and the signal from the change machine 4 is outputted to a low pass filter 6 through amplifier 5. Especially the low pass filter 6 in this invention is formed for antialiasing, and in order to prevent the clinch produced when a sampling period is short, it becomes effective.
[0011] A/D converter 7 is formed in the latter part of this low pass filter 6, and this converter 7 is performing the sampling to the switch timing of the above-mentioned change machine 4, and the timing which has a fixed relation so that it may mention later. As A/D converter 7, what has a high-speed successive approximation type or a high-speed flash plate type etc. is usually used. And the sampling data from A/D converter 7 are temporarily stored in storage meanses, such as a register which is not illustrated, and a signal-processing means (this example microprocessor 8 (CPU)) processes calculation of 0-degree component later mentioned to these data, or 90-degree component, amendment by the vector rotation operation, etc., and computes vector ratio voltage. Then, this vector ratio voltage is transformed into the voltage signal of an analog, and is sent to a proper output unit etc. In addition, in this example, since software realizes, a phase detection becomes unnecessary [a phase detector].
[0012] Hereafter, it explains using drawing 2 (A) - (C) focusing on the relation between switch timing with the change machine 4, and the timing of a sampling of A/D converter 7. Drawing 2 (A) is drawing showing both the waves of voltage Vpot and the conversion voltage Vcur. The period is the same although both have the arbitrary phase. Here, the change machine 4 of drawing 1 switches the output to Vcur or its reverse by turns from Vpot with one eighth of the periods (45-degree interval) of the above-mentioned measurement-signal period, and is outputting it to the next step. Drawing 2 (B) is the timing chart showing the situation of switching of the change machine 4, and the change state SW shows signs that Vpot is turned off and Vcur is [Vpot / ON and Vcur] turned on by OFF and the low, by the high level. In addition, the change is performed to timing unrelated to the phase of the above-mentioned measurement signal.
[0013] As shown in this drawing (C), A/D converter 7 is the same period as the period of the above-mentioned switching, and performs the sampling of Vpot or Vcur. However, when a sampling period is short, as for a sampling, it is desirable to carry out, after the output of the change machine 4 will be in a steady state. In this drawing (C), it is sampling near the pars intermedia of switching and switching. In addition, in this drawing (C), tX0, tX1, tX2, and ... have shown the sampling time of Vpot, and tY0, tY1, tY2, and ... have shown the sampling time of Vcur, respectively. Now, a sampling value [in / X0 X1, X2, ..., tY0, tY1 and tY2 of Vcur and ... / for the sampling value in tX0, tX1 and tX2 of Vpot, and ...] is made into Y0, Y1, Y2, and ... among these — for example, sampling numeric-value train XT=[X0 X1 X2 X3] T about Vpot — N1=[T] [1 0 -1 0] T and N2=[T] [0 -1 0 1] T If it takes advantaging, it can ask for two quadrature components (the 0-degree component Vpot0 and 90-degree component Vpot90) of the vector voltage of Vpot. Namely, the 0-degree component Vpot0 of Vpot,
[0014]
[Equation 1]
Vpot0=XT-N1/2 = (X0-X2)/2,
The 90-degree component Vpot90 of Vpot,
[0015]
[Equation 2]
Vpot90=XT-N2/2 = (-X1+X3)/2.
It can be alike and can ask more. the same — carrying out — sampling numeric-value train XT=[Y0 Y1 Y2 Y3] T of Vcur — N1=[T] [1 0 -1 0] T and N2=[T] [0 -1 0 1] T If it takes advantaging, it can ask for two quadrature components Vcur0 and Vcur90 of the vector voltage of Vcur. Namely, the 0-degree component Vcur0 of Vcur,
[0016]
[Equation 3]
Vcur0=YT-N1/2 = (Y0-Y2)/2.
90-degree component Vcur90,
[0017]
[Equation 4]
Vcur90=YT-N2/2 = (-Y1+Y3)/2.
It can be alike and can ask more. By the way, by this invention method, the sampling of Vpot and Vcur is not performed by being in phase. That is, the system of coordinates based on the sampling phase of Vpot and the system of coordinates based on the sampling phase of Vcur are not the same. Therefore, although it is necessary to change the above Vpot0 and Vpot90, and Vcur0 and Vcur90 into the same system of coordinates, a vector rotation operation or a complex operation can amend this conversion easily so that it may state below. If the value after Vcur0' and amendment of Vcur90 is set to Vcur90 for the value after amendment of Vcur in order to double Vcur with the phase of Vpot

[0018]
[Equation 5]
Vcur0'=Vcur0, cos45 degree+Vcur90, and sin45 degree.
= (Vcur0+Vcur90) /21/2.
Vcur90'=-Vcur0 and sin45 degree+Vcur90, cos45.
**.
= (-Vcur0+Vcur90) /21/2.
It can ask for a vector voltage ratio (0-degree component is Vpot0/Vcur0', and 90-degree component is Vpot90/Vcur90') easily from each next door and above-mentioned formula.
[0019] In the above-mentioned example, although the change period of the change machine 4 was set as 45 degrees (1/8 of a measurement cycle), if it is an angle smaller than 90 degrees (1/4 of a measurement cycle), various kinds of periods, such as 60 degrees (1/6 of a measurement cycle) and 30 etc. degrees (1/12 of a measurement cycle), are employable. For example, as shown in drawing 3 (A), the change period of the change machine 4 is set as 60 degrees (1/6 of a measurement cycle), and it is **. For example, the first sampling is performed from the change time tX0 about **Vpot at the time of 45-degree progress, the sampling of the beginning about **Vcur is performed from the change time tY0 at the time of 45-degree progress, the 2nd sampling about **Vpot is performed from the change time tX1 at the time of 15-degree progress, and the 2nd sampling about **Vcur is performed from the change time tY1 at the time of 15-degree progress. If a sampling with Vpot and Vcur is performed one by one at time tX2, tY2, tX3, and tY3 like the following, Vpot0, Vpot90, Vcur0, and Vcur90 can be calculated like the above. And it can ask for a vector (amendment which delays Vcur0 and Vcur90 [60-degree] in this case is carried out) voltage ratio by giving amendment which doubles the phase of Vcur0 and Vcur90 with Vpot0 and Vpot90, for example. In addition, the measuring time in this case can be made into about 2/3 time compared with the former.